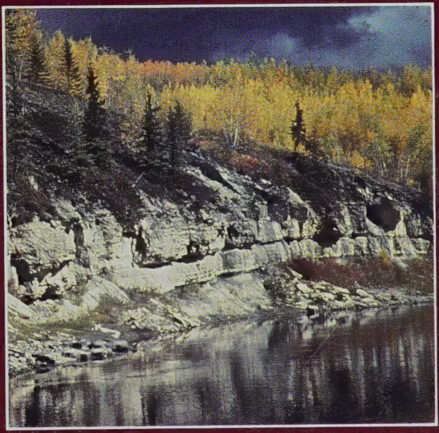
Alberta Geological Survey



Alberta
RESEARCH COUNCIL
Natural Resources Division

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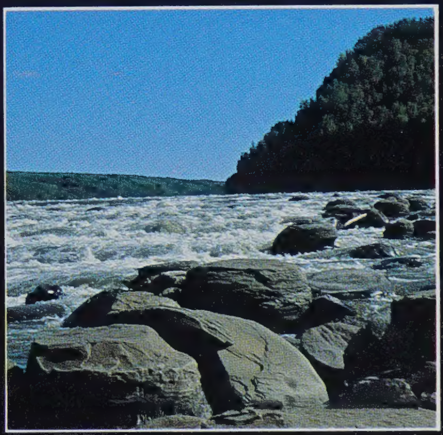

Alberta has a rich and varied geological heritage. It is exemplified in many ways by the mountain region, where Cordilleran deformation has brought virtually all of the important formations to the surface where they can serve as a natural field laboratory for the research geologist. The bulk of Alberta's earth resources, however, lie in the subsurface beneath the Plains and Parkland regions (inset photos). Extensive geological data from borehole logs and cores form a basis for subsurface research and survey work that both rivals and complements that of the surface exposures. The Alberta Geological Survey is uniquely placed to decipher and synthesize both the surface and subsurface elements of these remarkable geological realms.

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INTRODUCTION

The Alberta Geological Survey is a department in the Natural Resources Division of the Alberta Research Council, a provincial crown corporation dedicated to promoting the economic development of Alberta through science and technology. Founded in 1921 and currently employing over 500 staff, the Alberta Research Council is the oldest and largest provincially sponsored research organization in Canada.

The Alberta Research Council's matrix organization features five research programs: Natural Resources; Oil Sands; Coal; Frontier Sciences; and Industrial and Engineering Research. The Alberta Geological Survey contributes to the first three programs.

OBJECTIVES

The mandate of the Alberta Geological Survey is to establish the geological framework of the province and to make this knowledge available to both public and private sectors, as the basis for decisions on a broad range of matters relating to man's interaction with the earth and its resources.

In striving to build a comprehensive understanding of the geology of Alberta, the Alberta Geological Survey emphasizes the following objectives:
1) to ascertain the nature and origin of Alberta's energy and mineral resources;
2) to foster the exploration for and enlightened development of these resources;
3) to identify those dynamic geological processes which affect society, be they natural hazards or man-induced phenomena;
4) to advise the government on matters relating to geological features and processes; and
5) to provide geological information to both the public and private sectors, through publications, open-file reports, conferences, consultation, and other services.

ACTIVITIES

The Alberta Geological Survey is involved in three types of activities:
1) geological surveys, which involve mapping the surface and subsurface geology of the province and compiling earth resource inventories;
2) research, with applied research emphasis on strata and deposits of actual or potential economic interest, but including a measure of basic research;
3) information and advisory services in the form of publications, conference presentations, courses, seminars, consultations and responses to enquiries.

Alberta Geological Survey staff are also active in regional, national and international earth science societies and their associated professional activities.

UNIQUE STATUS

Unlike other provincial geological surveys, the Alberta Geological Survey has no direct legislative or regulatory responsibility and is not specifically involved in computing mineral or energy reserves. In Alberta, these functions are respectively discharged by Alberta Energy and Natural Resources and the Alberta Energy Resources Conservation Board. Both of these bodies, plus Alberta Environment, have in-house geological expertise. These jurisdictions and the Alberta Geological Survey avoid duplication of effort through close liaison and cooperation. The Alberta Geological Survey also maintains close ties with the Geological Survey of Canada,

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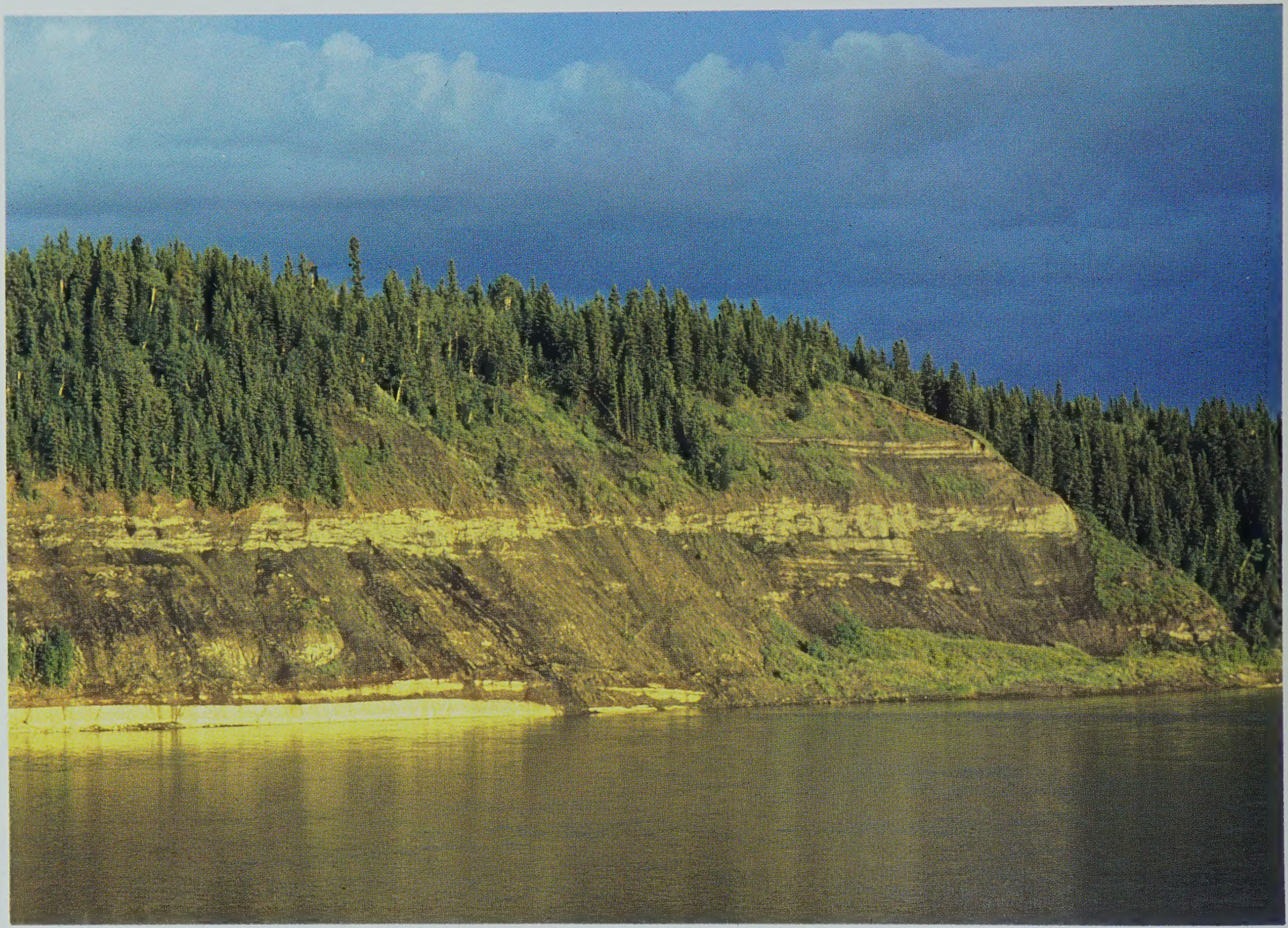
largely through contact with scientists of the Calgary-based Institute of Sedimentary and Petroleum Geology.

The Alberta Geological Survey seeks to complement the activities of other provincial government departments, industry, and academia. Although its services and facilities are available to paying clients in both the public and private sectors, the Alberta Geological Survey makes a conscious effort to avoid competition with professional consulting geologists and commercial laboratories.

ORGANIZATION

The Alberta Geological Survey has four main sections — Oil Sands Geology, Sedimentary Geology, Mineral Resources and Environmental Geology. Each section consists of 6 to 10 professionals and approximately equal numbers of support staff, and is administered by a Section Manager who reports to the Department Head.

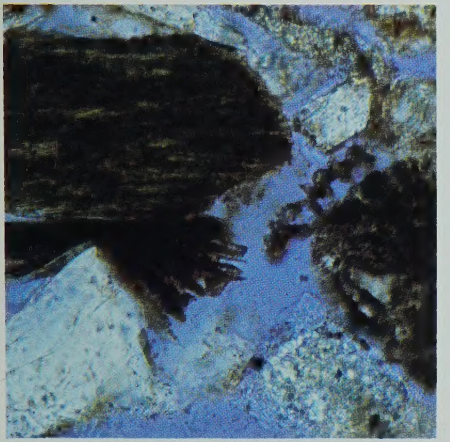
Oil Sands Geology

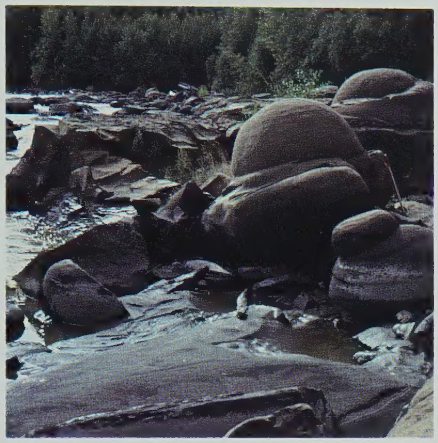


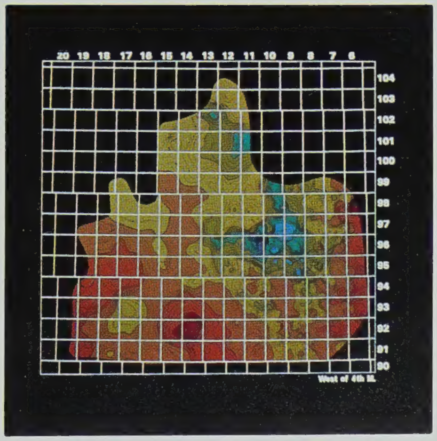
Oil Sands Geology research involves petrologic studies, facies analysis of subsurface and surface sequences, and interpretative mapping of entire deposits.

ABOVE: An oil field at outcrop - the bitumen-saturated McMurray Formation on the Athabasca River.

RIGHT: Fibrous dawsonite in sediments of the Peace River Oil Sands - scanning electron micrograph.







TOP: Athabasca Oil Sands, saturated by bitumen that is immobile at reservoir and surface temperatures.

ABOVE LEFT: Porous Grand Rapids Formation sand with compactionally deformed mica booklet - thin-section photomicrograph.

ABOVE RIGHT: Grand Rapids Formation concretions of the type that are common in the Wabasca Oil Sands.

RIGHT: Structure contours on the Pre-Cretaceous unconformity beneath the McMurray Formation - Northern Athabasca Deposit.

Alberta Research Council geologists have conducted research and survey programs in the oil sands since the mid 1950s. At present, there is ongoing geological research on the Athabasca, Wabasca, Peace River and Cold Lake Oil Sands, the Heavy Oil Belt from Lloydminster to Suffield and the Subcrop Carbonate Trend. The work is funded jointly by the Alberta Research Council and the Alberta Oil Sands Technology and Research Authority (AOSTRA).

The oil sands projects share a common objective: to gain an understanding of the facies and reservoir characteristics of the oil sands and heavy oil deposits of Alberta, and relate this information to the development of recovery and extraction technologies.

Each study has three distinct but related components:

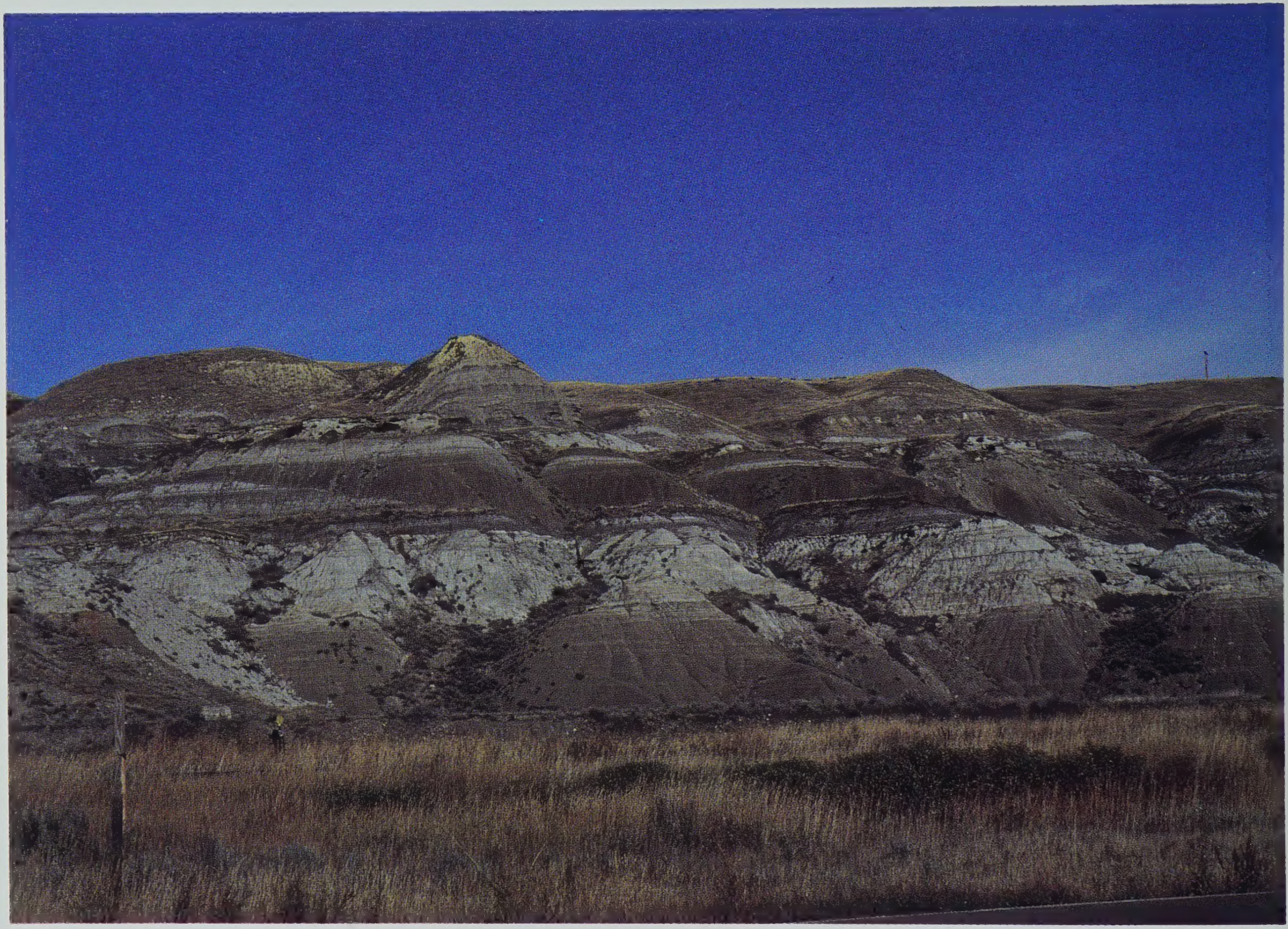
1) petrologic characterization of the reservoirs and the enclosing rocks (mineralogy, texture, porosity, permeability, saturations, and so on), to determine geotechnical behavior and assist with physical and numerical model development;

2) facies analysis (depositional environments, paleogeography), in order to develop predictive capability regarding the three-dimensional geometry of the reservoir sands and the intervening shales in the subsurface; and

3) regional mapping of entire deposits (structural maps, isopachs, sand/shale ratio maps, bottom water maps, net pay maps, for example) as a basis for decisions regarding reserves estimation, pilot plant siting, and process transferability.

The primary goal of oil sands geology research is to generate public information, but there are also two specific applications areas. First, program personnel support oil sands engineering and chemical research in other parts of the Oil Sands Research Program. As well, Alberta Geological Survey geologists act as technical advisors for the industry field pilot programs in which AOSTRA has a working interest. Information and insight gleaned from this function is maintained in confidence for the companies and AOSTRA.

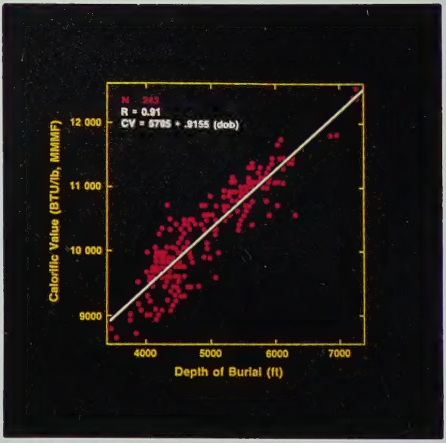
Sedimentary Geology

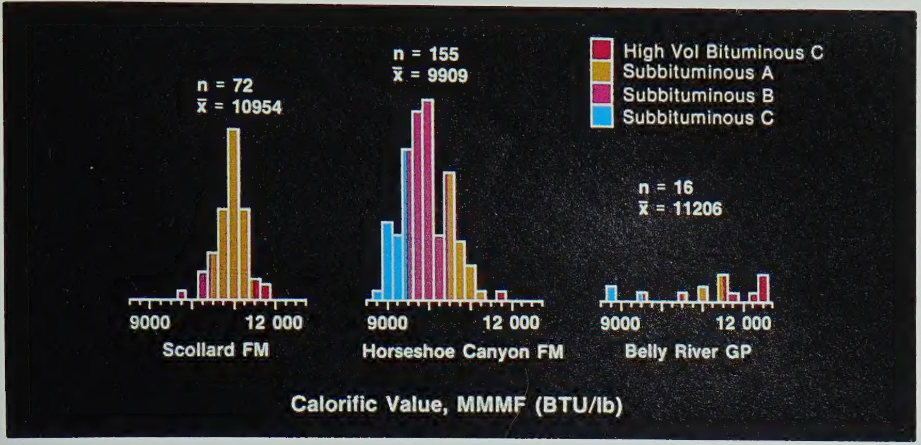


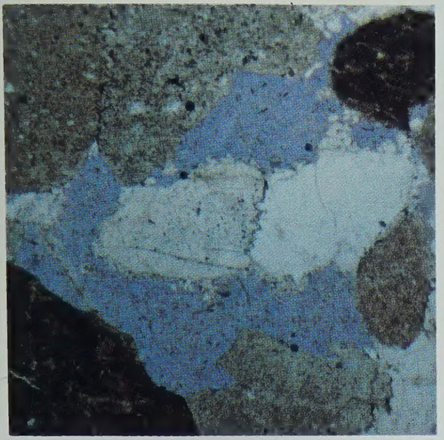
Research in Sedimentary Geology focusses on the coal-bearing strata of Alberta and on specialized research in petroleum geology, ichnology (trace-fossils) and palynology.

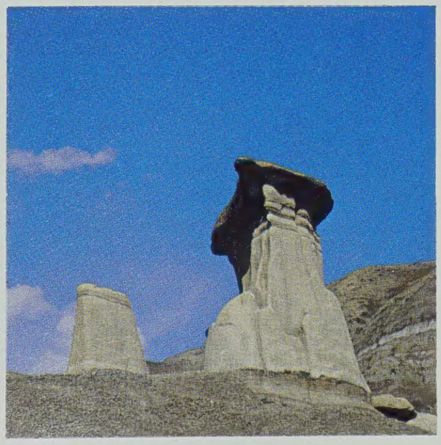
ABOVE: Coal-bearing Horseshoe Canyon Formation strata exposed in the Red Deer Valley near Drumheller.

RIGHT: Cross-plot of coal rank versus reconstructed depth of burial.









TOP: Distribution of coal ranks in the Alberta Plains.

ABOVE LEFT: Gas-bearing Spirit River Formation conglomerate in the Deep Basin of Northwestern Alberta - thin-section photomicrograph.

ABOVE RIGHT: Deformed coal seam at Grassy Mountain near Blairmore.

RIGHT: Hoodoos in the coal-bearing Bearpaw/Horseshoe Canyon transition near Drumheller.

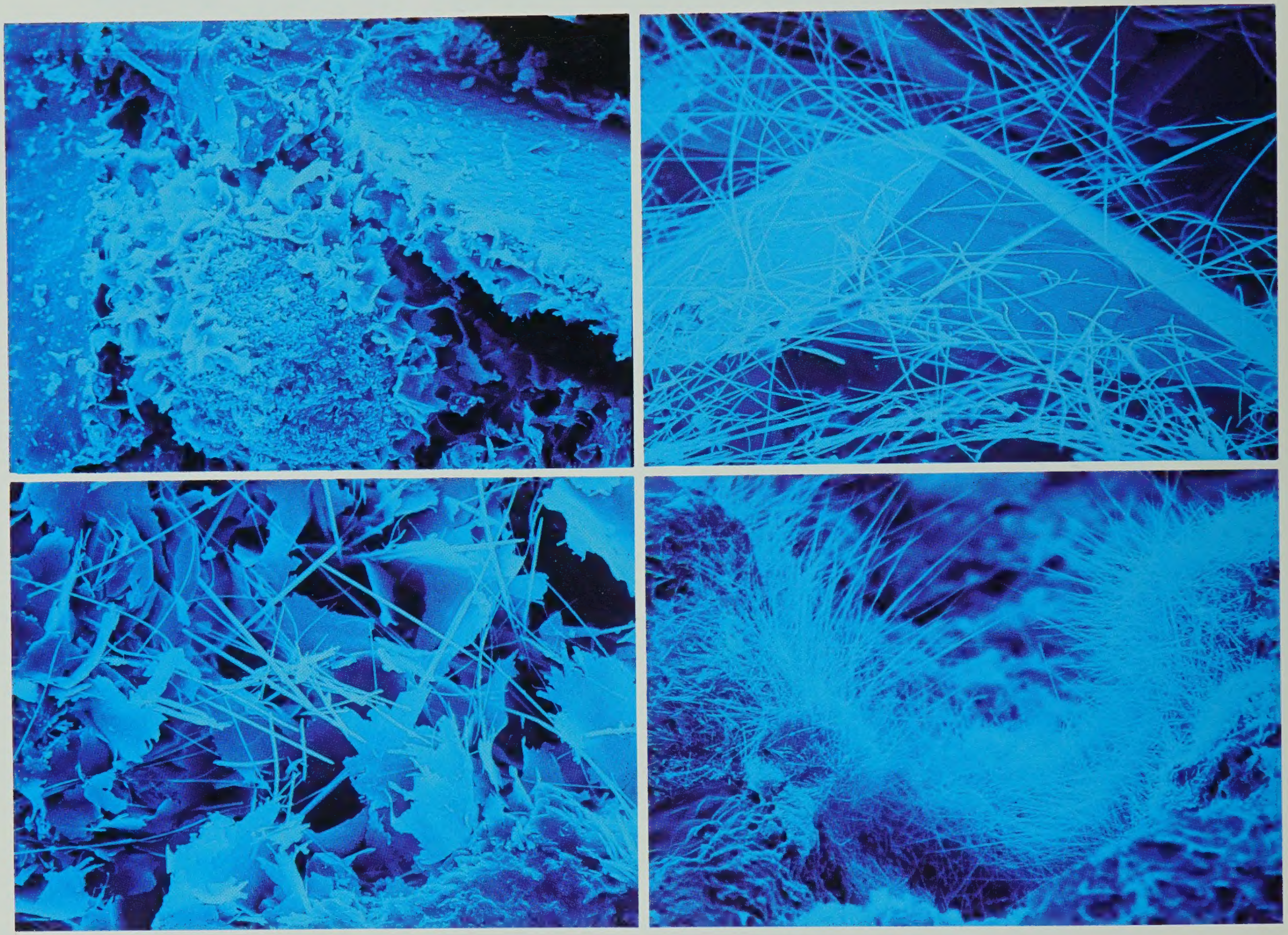
Research in the Sedimentary Geology Section of the Alberta Geological Survey has two fundamental components:
1) geology of the Cretaceous coal measures of the Alberta Plains;
2) specialist studies in selected areas of palynology, ichnology and petroleum geology, as they relate to the fossil fuel resources of the province. The coal study is funded jointly by Alberta Energy and Natural Resources and the Alberta Research Council. The specialist research is supported entirely by the Alberta Research Council's grant.

In the mid to late 1970s, the Alberta Research Council conducted systematic regional-scale drilling programs to evaluate the principal Cretaceous coal-bearing units of the Alberta Plains, to depth of about 400 metres. This bank of subsurface stratigraphic data is being augmented by detailed outcrop studies on the facies and depositional environments of the relevant Cretaceous strata. Facies interpretations obtained from surface outcrop can be extrapolated into the subsurface and used as a tool for predicting seam thickness, continuity, and chemical variability. The Alberta Geological Survey also conducts research related to coal chemistry and rank, and to log/core correlations in coal-bearing sequences.

The remainder of the Sedimentary Geology Section consists of specialist scientists whose work complements Geological Survey initiatives in other areas. Palynological research concentrates on various Cretaceous stages in the Alberta basin, as well as studies supporting facies work on oil sands, coal and petroleum-bearing strata. Similarly, specialized ichnological expertise is brought to bear on the stratigraphic, paleontological and sedimentological implications of trace fossils in Alberta's economically important sequences. Geological research on petroleum and natural gas accumulations in the Alberta subsurface is presently focussed on the Deep Basin of northwestern Alberta. In coming years, this work will be broadened to encompass petroleum geology investigations on many of Alberta's potentially productive horizons.

Cretaceous megaspore species in sediments of the Peace River area - *Arcellites disciformis*.

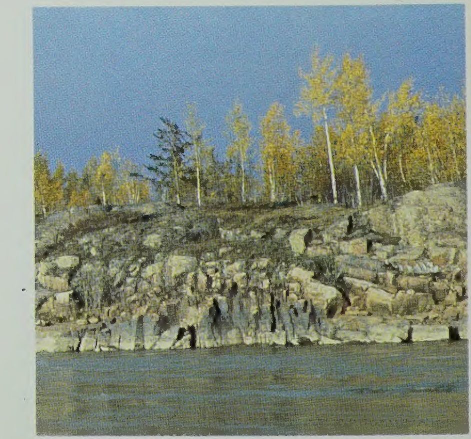
Mineral Resources

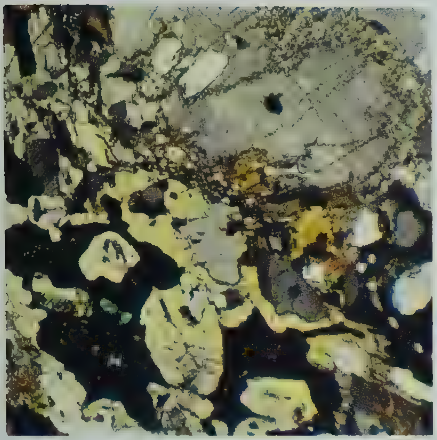


Mineral Resources research includes geological survey mapping and resource inventory assessment of virtually all of the economically important rocks of Alberta, from the Precambrian Shield of northeastern Alberta, through the Parklands and Plains to the mountains.

ABOVE: Fibrous cristobalite and platy illite in orthoquartzites of the Proterozoic Athabasca Sandstone - scanning electron micrographs.

RIGHT & TOP LEFT: Precambrian granitic terrain exposed along an outlet from Lake Athabasca.





ABOVE: Granulite from the Precambrian in northeastern Alberta - thin-section photomicrograph, crossed-nicols.

ABOVE RIGHT: Backhoe excavation to assess the aggregate potential of oil sand overburden, near McClelland Lake.

RIGHT: Gravel pit operation near Medicine Hat.

Alberta has relatively few metallic mineral resources, although there is considerable exploration potential in the northeastern corner of the province and in the disturbed belt. Projects to assess this potential include a detailed and comprehensive geological survey of the Precambrian Shield in northeastern Alberta, a study of the Clear Hills iron formation in the Peace River country and numerous small studies of bedrock and alluvium in the plains and foothills.

Industrial mineral resources in Alberta are abundant and diversified. Their development is a crucial factor in Alberta's economic health, and their management is a priority concern for both industry and government. Research and resource surveys by the Alberta Geological Survey touch on virtually all of these commodities — industrial clays, silica, phosphate, marl, gypsum, salt, limestone, granite, sulfur, heavy minerals — as both primary resources and by-products from the beneficiation of other earth resources. Many of these commodities are very sensitive to land management and zoning restrictions. The Alberta Geological Survey maintains current files to assist in enlightened management and planning.

Aggregate is perhaps the most important industrial mineral commodity in the province. Since 1976, Alberta Energy and Natural Resources has funded an ongoing geological survey of gravel, sand, mineral and expanded aggregate. The aggregate inventory project involves a close working liaison with users in resource development and land-use planning.

The Mineral Resources Section also conducts research and survey work on the structural geology of coal-bearing rocks in the foothills and front ranges and on the uranium potential of the Athabasca Basin in northeastern Alberta. In relation to the latter research, the Alberta Research Council operates a public facility for the storage and examination of drill cores generated by mineral exploration activity in the province.

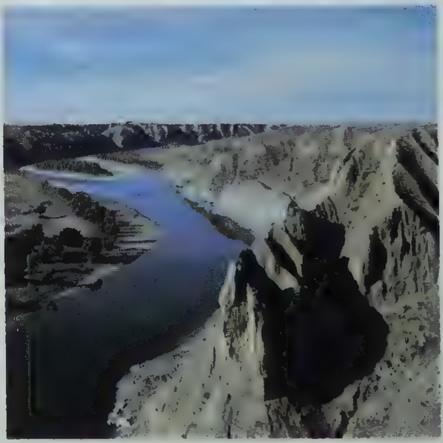
Another of the Alberta Geological Survey's major public service commitments, the GEODIAL index of literature on the geology of Alberta, is also managed by the Mineral Resources Section. The file is used increasingly for scientific and commercial purposes.

Environmental Geology

Environmental Geology research has two components: surficial geology and Quaternary stratigraphy of the glacial sediments of Alberta; and reclamation, particularly as it relates to coal mining.

ABOVE: Light-coloured glacial till in an overburden position above potentially mineable oil sands of the McMurray Formation, near Fort MacKay.

RIGHT: Multiple till sequence on the Oldman River near Taber.



TOP LEFT: Field drilling operation to assess the pre-mining characteristics of overburden above coal-bearing strata in the Wabamun area.

ABOVE: Glacially sculpted mountain terrain west of Nordegg.

ABOVE RIGHT: Reclamation-related fieldwork in the Grande Cache coal district.

RIGHT: Fieldwork on the Firebag River, to assess the characteristics of the overburden above the Athabasca Oil Sands.

The Environmental Geology Section is concerned with the surficial geology and Quaternary stratigraphy of the province and with reclamation, particularly as it relates to plains coal mines.

Nearly all of Alberta is mantled by Quaternary sediments of glacial or related origin. These sediments contain important mineral and water resources, and their geological and geotechnical characteristics have very significant impact on the agriculture and forest industries in the province as well as on a broad range of rural and urban land-use planning issues. The Alberta Geological Survey projects are concentrated in three areas:
1) surficial geological mapping, normally published on a scale of 1:250,000;
2) the stratigraphy and geological history of the Quaternary sequence, as revealed in comprehensive drilling programs;
3) applied research on areas of resource potential and/or environmental concern. Results of the work are made available to both the private and public sectors as fundamental input to the planning and development process. The Alberta Geological Survey currently has active projects in southern Alberta, the Edmonton-Lloydminster-Cold Lake region, and in the Athabasca Oil Sands area.

Decisions regarding the reclamation of disturbed lands are extremely difficult for governments and developers alike. Background information is lacking on the virgin characteristics of the ground, and comprehensive documentation of potential land-use options is not commonly available.

These issues are addressed by the Plains Hydrology and Reclamation Project, which adopts a holistic approach to reclamation through integration of geological, hydrological and soils investigations, not only in active mining areas but also in immediately adjoining unmined lands. This approach permits the assessment of environmental impacts and long-term performance. The current project focusses on the surface coal mining enterprises at Forestburg and Wabamun. The project is funded by the Alberta Heritage Trust Fund, authorized by the Land Conservation and Reclamation Council.

FUNDING

Approximately one-third of the Alberta Geological Survey's annual budget comes from the Provincial Treasury as part of the normal operating grant to the Alberta Research Council. The balance is largely supplied by the departments and agencies of the provincial government that use the unique research capabilities of the Alberta Geological Survey. Contract work for industry generates a small revenue.

FACILITIES AND PERSONNEL

The offices of the Alberta Geological Survey are located in Terrace Plaza on Edmonton's south side. The main laboratory facilities, in the Alberta Research Council's building on the University of Alberta campus, include the sedimentation laboratory (oil extractions, grain size analysis, thin-sections, and so on), the X-ray laboratory (preparation and diffraction), the ceramics laboratory (clay firing), the palynology laboratory (separation and mounting), the Quaternary laboratory (gravel and till analyses) and the scanning electron microscope facilities. Wet chemical analysis, X-ray fluorescence, computing services, machine shop and other facilities are also available.

The Alberta Geological Survey employs approximately sixty scientists and technical personnel. Most research officers have university training at the Ph.D. level. The remainder have M.Sc. or B.Sc. qualifications. The research staff embodies a broad range of geological expertise and specialization, concentrated in the areas of stratigraphy and sedimentology, reflecting the dominantly sedimentary character of Alberta's rocks.

RESULTS

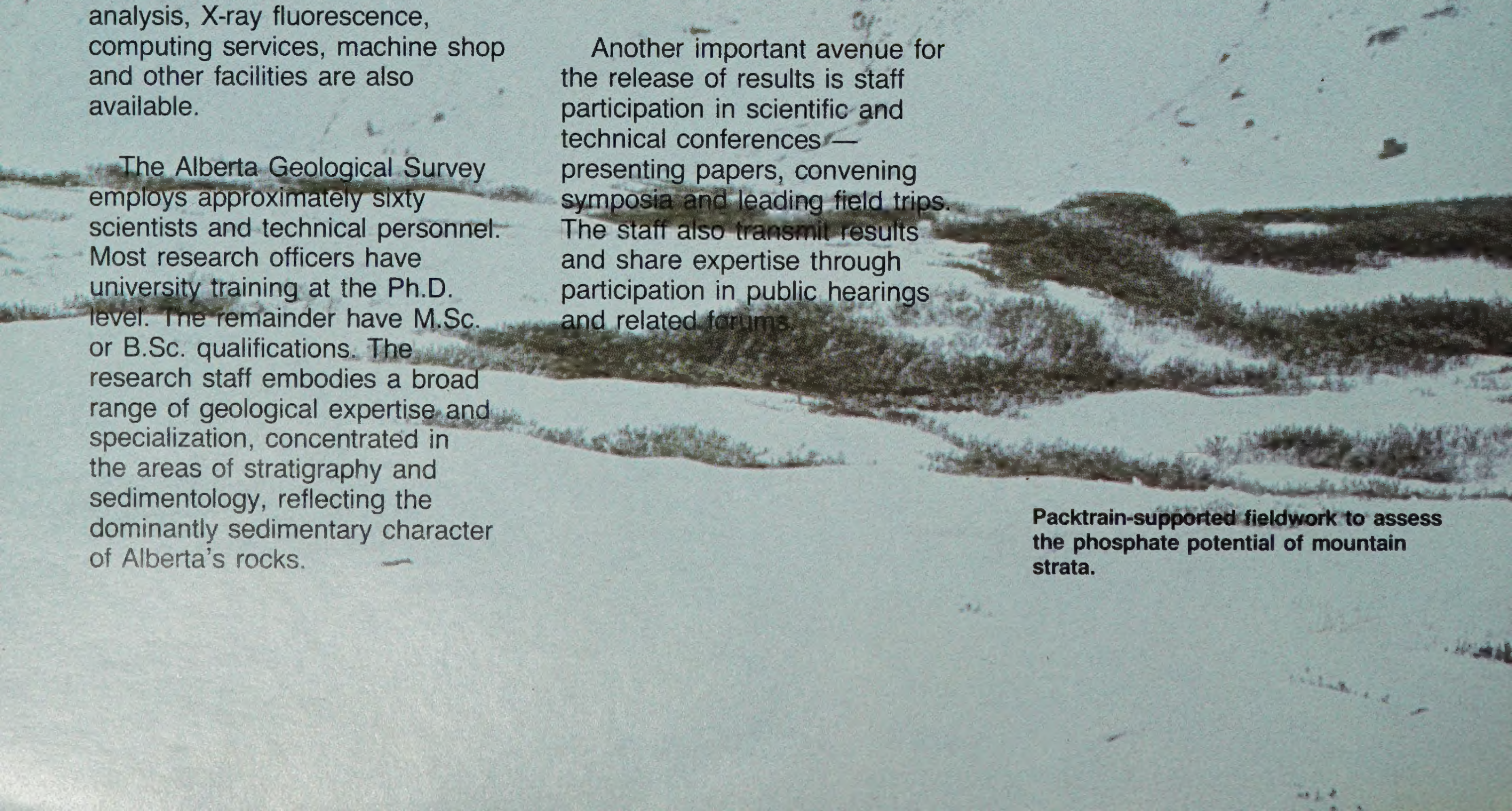
Most research and survey work conducted by the Alberta Geological Survey is funded by public monies and much of the input data for the studies is derived from the public domain. Consequently, results of the work are widely circulated in both the public and private sectors. Scientific papers and reports resulting from the various projects are commonly published in technical journals. In addition, the Alberta Research Council produces its own publications — maps, Bulletins, Earth Science Reports and open file reports. These documents contain virtually all of the salient results of Alberta Geological Survey investigations.

Another important avenue for the release of results is staff participation in scientific and technical conferences — presenting papers, convening symposia and leading field trips. The staff also transmit results and share expertise through participation in public hearings and related forums.

The Alberta Geological Survey also maintains a formalized information geology service, backed by all of its resident expertise and by the GEODIAL index. Enquiries from industry, government, the media and the public are coordinated through this function.

OUTREACH

The Alberta Geological Survey sponsors outreach initiatives to various scientific, regulatory, educational and commercial groups. The Alberta Geological Survey holds an Open House every two years that attracts people from industry, government and academia. The Open House is an all-day session of oral presentations and poster displays on all of the projects and services of the organization. The event allows those who attend an opportunity to discuss problems and issues with research officers and technical staff, and provides access to the most recent findings.



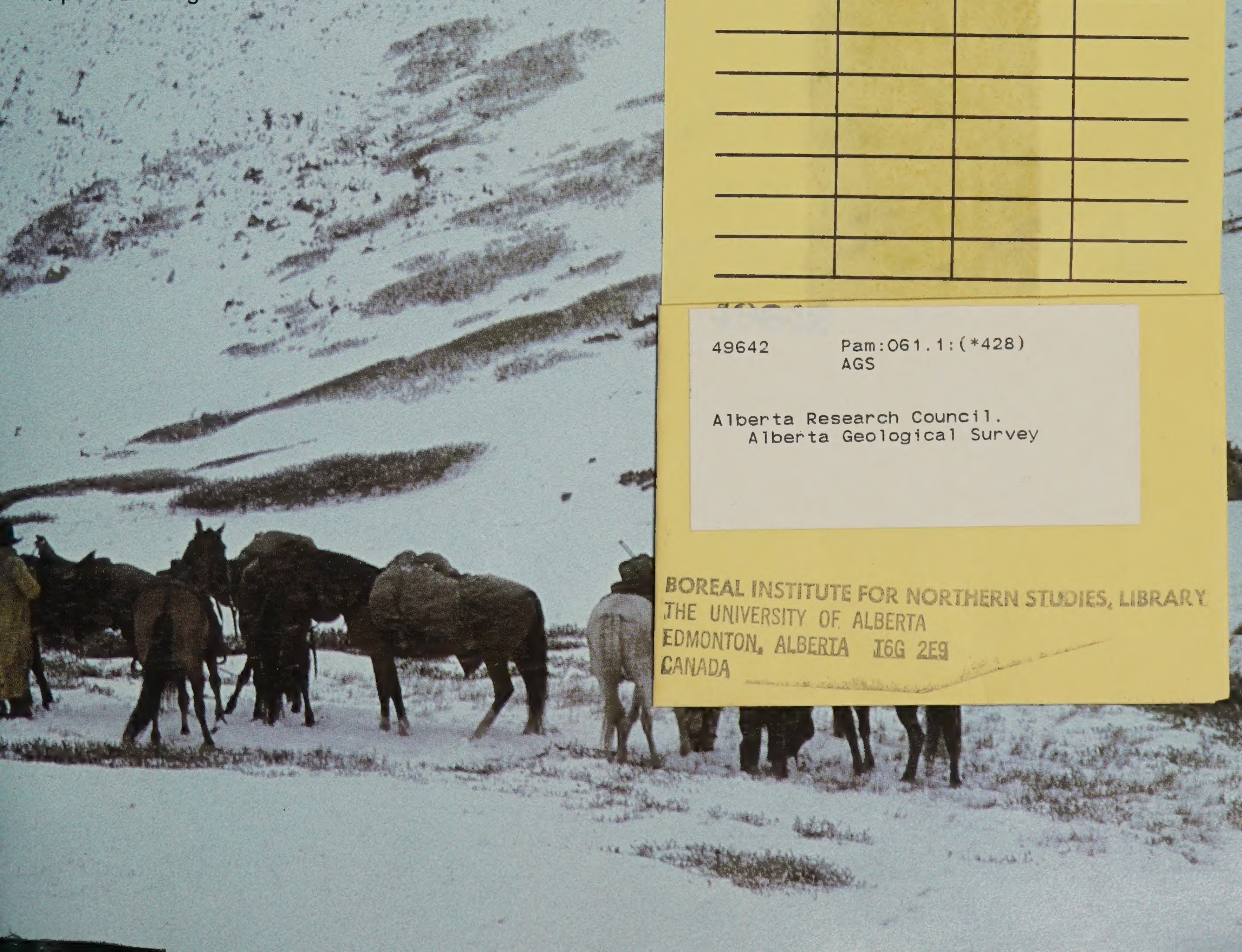
Packtrain-supported fieldwork to assess the phosphate potential of mountain strata.

In the educational realm, Alberta Geological Survey staff teach specialist earth science courses for professional societies, and take part in lecture tour programs. Individual staff members also teach curriculum and extension courses at the University of Alberta, the University of Calgary and Red Deer College, and participate in courses for earth science school teachers in the Edmonton area through the EDGEO program.

The Alberta Geological Survey promotes two university outreach activities. It provides summer employment opportunities for 20 to 25 earth science students, and sponsors a limited amount of graduate student research. The Alberta Geological Survey also helps train foreign students.

Regional, national and international earth science societies and commissions receive considerable input from Alberta Geological Survey Staff. As well, Alberta Geological Survey scientists regularly undertake critical review of journal manuscripts, and some staff members edit special publications or individual journals.

The Alberta Geological Survey has the mandate and the expertise to contribute meaningfully to the ongoing quest for better knowledge of Alberta's geology and earth resources. The long-term importance of this quest cannot be underestimated.



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